

# COUPP/PICO Status Report

Russell Neilson, University of Chicago  
for the PICO Collaboration

Fermilab All Experimenters Meeting, 16 December 2013

# PICO Collaboration



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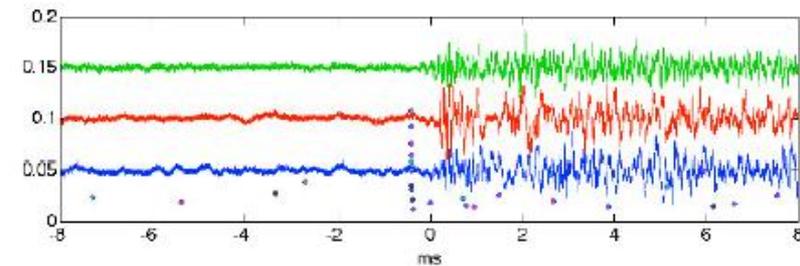
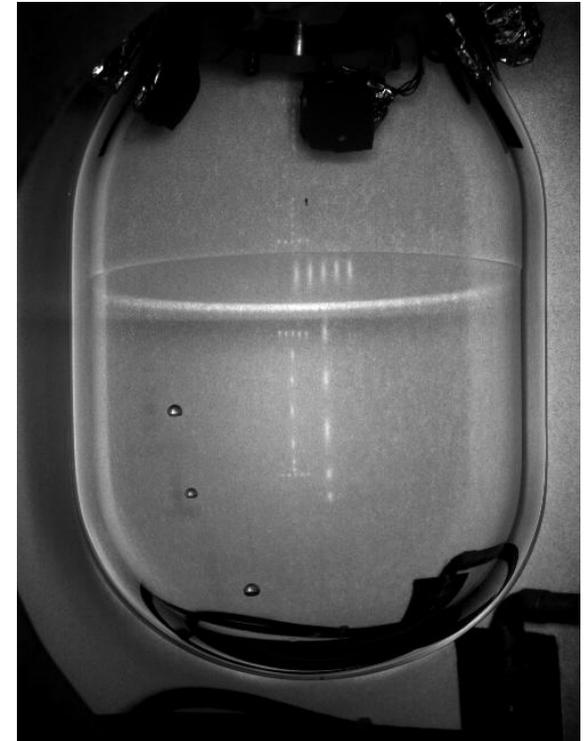
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I. Lawson,  
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# PICO bubble chambers

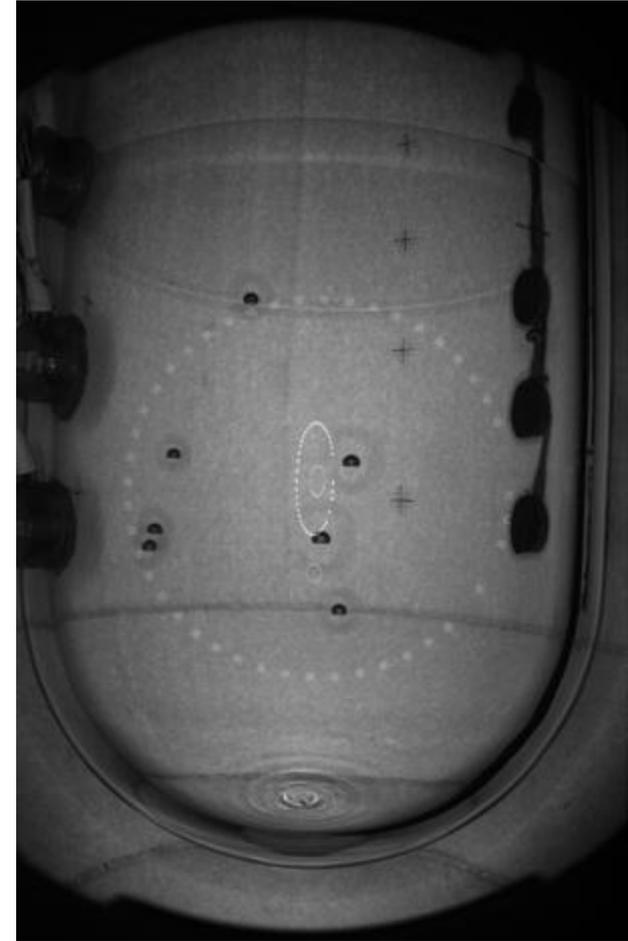
- Eg. COUPP-4: superheated fluid 4 kg of  $\text{CF}_3\text{I}$
- Observe bubbles with two cameras and piezo-acoustic sensors.



# COUPP-60

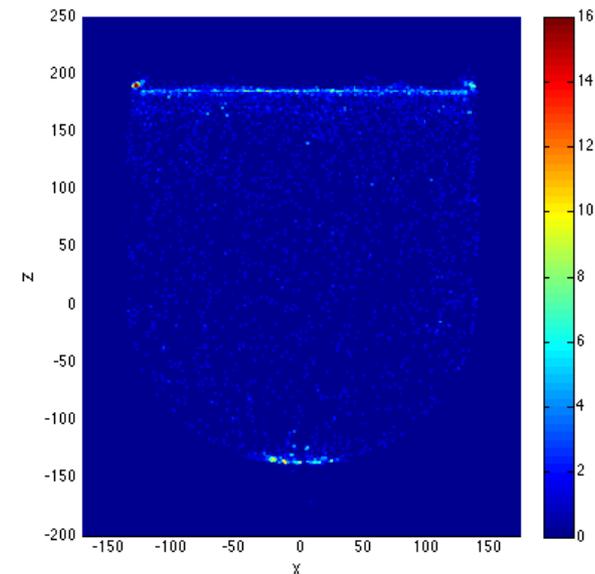
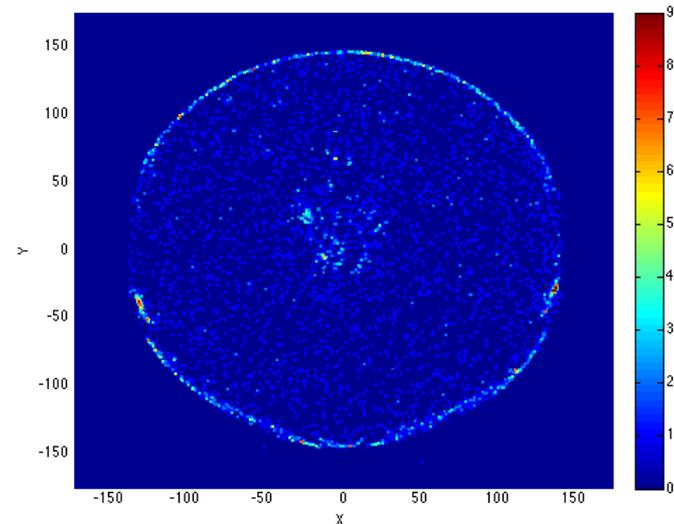


- 37kg  $\text{CF}_3\text{I}$  target (75kg possible in future).
- Taking data since June 2013 at SNOLAB (with ~ 2 month break to fix a hydraulic leak).
- More than 1500 kg-days exposure so far at a variety of thresholds.



# COUPP-60 data

- Zero multiple bubbles
  - No neutron background.
- But, a population of events that sound similar to nuclear recoils but are clearly not WIMPs.
  - Non-istropic distribution.
  - Time dependence.
  - Appear louder on average than nuclear recoils.
  - This population is being studied in detail.

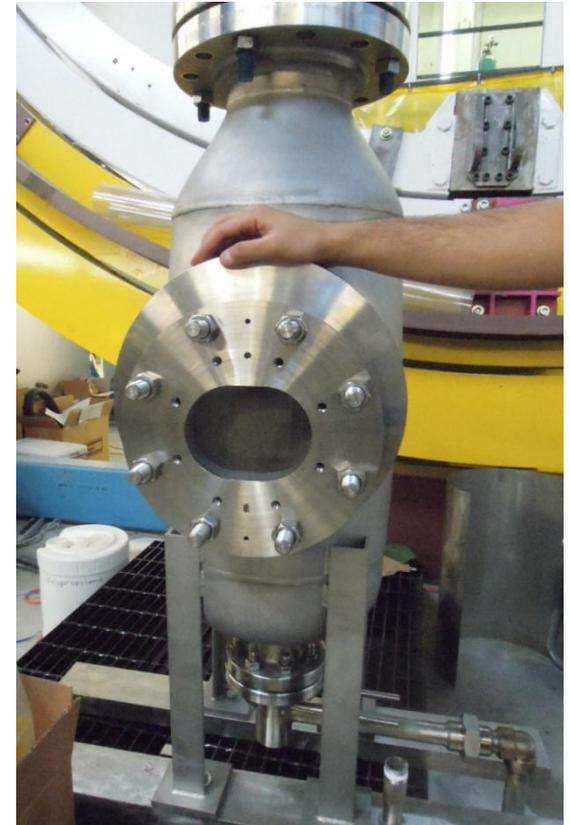


# PICO-2L

- Two liter active mass (same as COUPP-4):
  - Re-uses COUPP-4 location, neutron shield, other infrastructure.
- New active fluid
  - $C_3F_8$  instead of  $CF_3I$ .
  - Better fluorine sensitivity:
    - Twice the F density.
    - Lower threshold.
    - Improved efficiency.
    - More stable chemistry.
- New hardware:
  - Lower background.
  - Simpler controls.
  - Prototyping for ton-scale experiment.



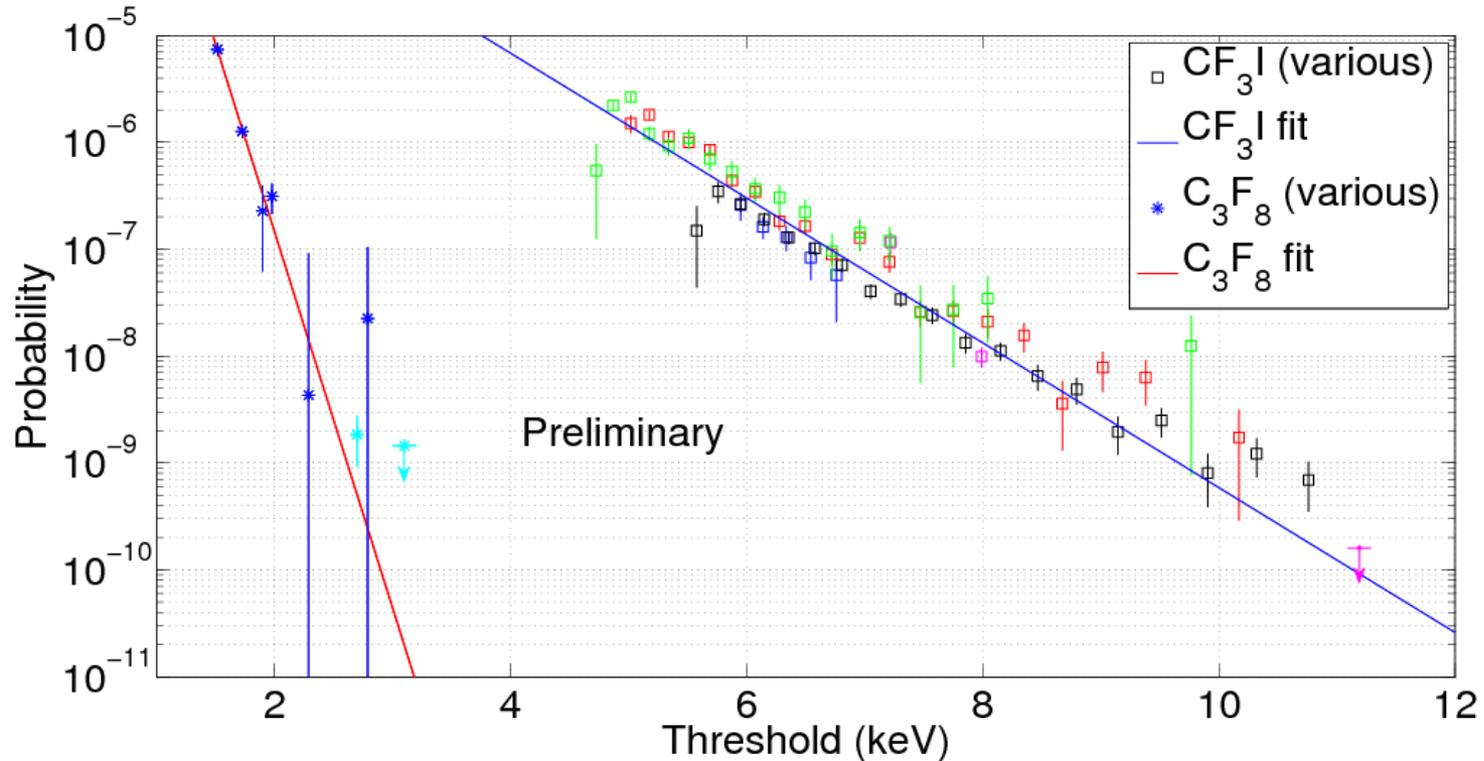
New two-bellows design inner vessel assembly. Silica jar is an exact replica of COUPP-4 jar.



Simplified pressure vessel –  $\frac{1}{4}$  the mass of steel as COUPP-4.

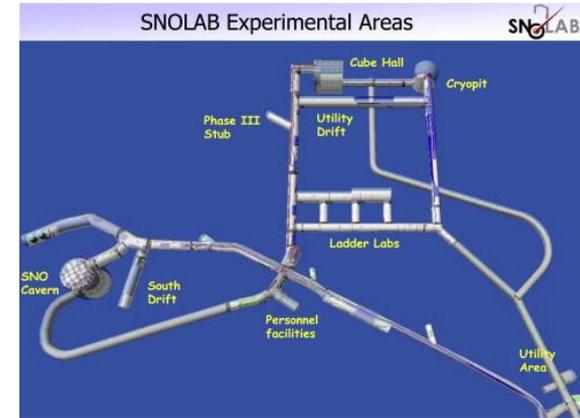
# Electron recoil rejection

Bubble nucleation probability from gamma interactions in  $C_3F_8$  and  $CF_3I$



Preliminary results suggest the same  $10^{-10}$  gamma rejection is possible with  $C_3F_8$ , and at a lower nuclear recoil threshold. A lower threshold extends the sensitivity to lower mass WIMPs.

# PICO-2L installation at SNOLAB

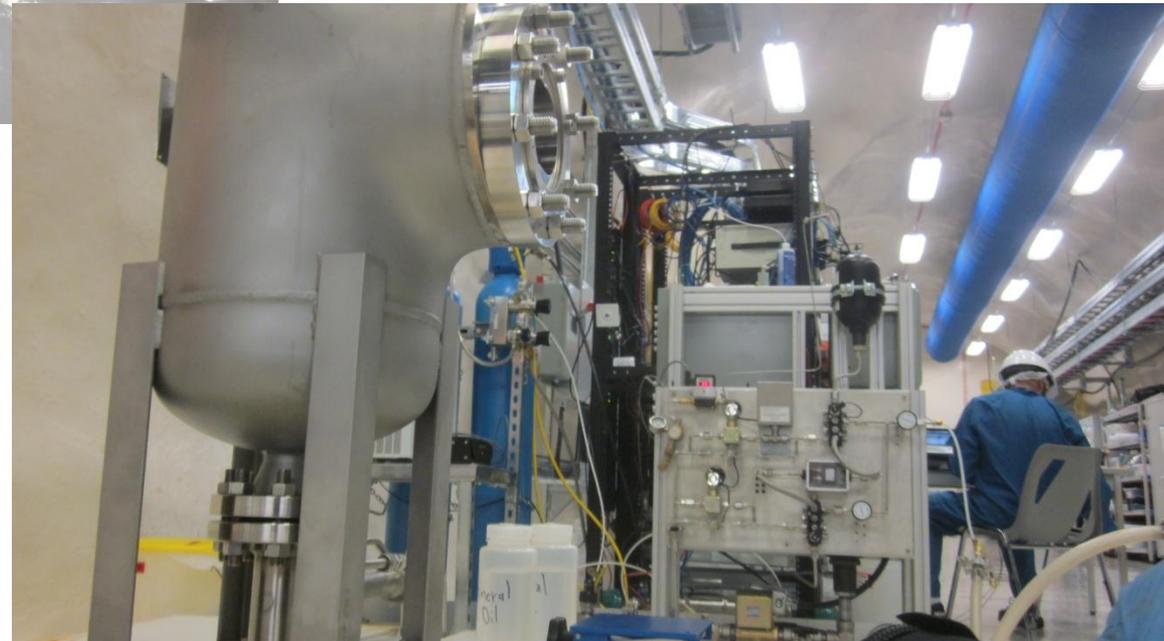


PICO-2L installed at SNOLAB in old COUPP-4 location.

Dark-matter data taking began Oct 28<sup>th</sup>, 2013.

Approx 100kg-days exposure so far, mostly at 3keVnr threshold.

AEM December 16th, 2013



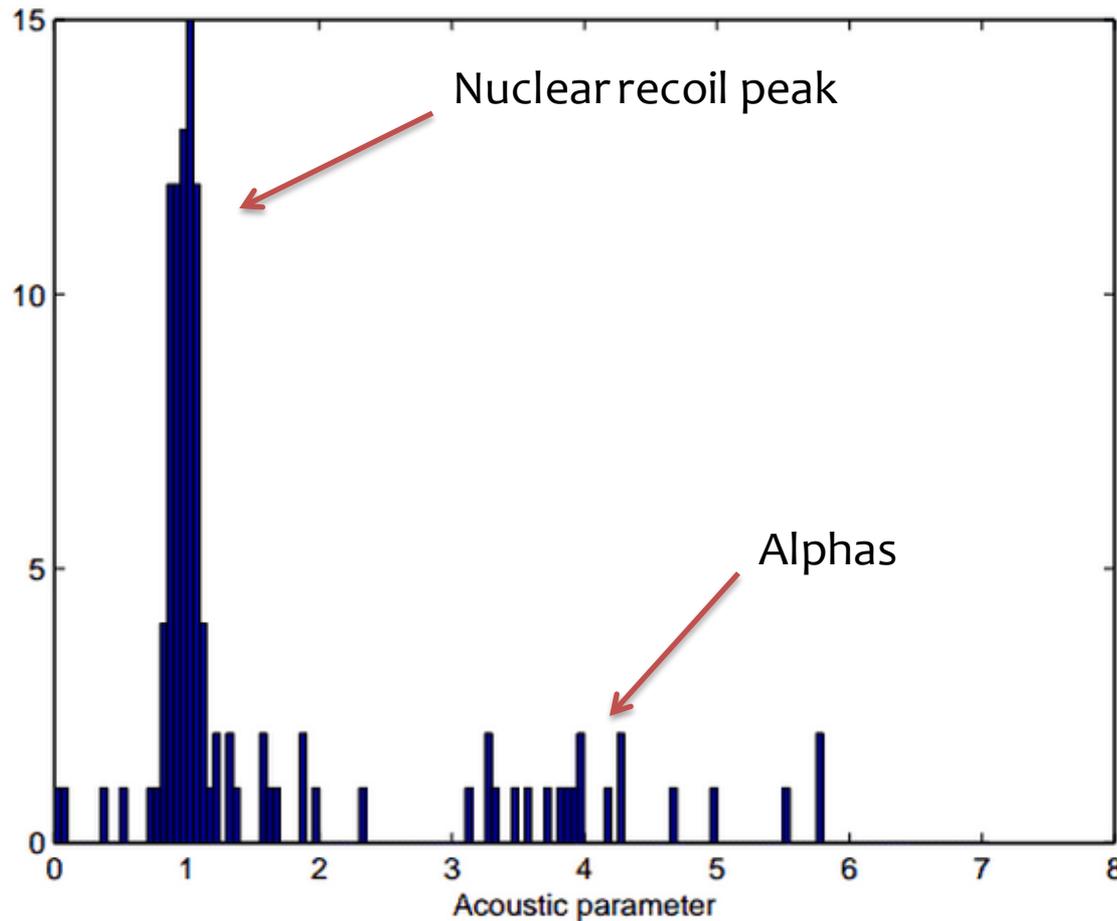
Russell Neilson, University of Chicago

# PICO-2L ten-bubble AmBe neutron event

The screenshot displays the DAQ301 software interface, which is used for controlling and monitoring the PICO-2L experiment. The interface is divided into several sections:

- Manual Controls:** Includes a 'Compress' control with a 'New Value' of 50 and an 'UPDATE!' button.
- Manual Expand:** Features 'Begin Run' and 'End Run' buttons, along with a 'Presurized' indicator.
- Manual Trigger:** Includes 'End Run' and 'Stop DAQ' buttons, with a 'STOP' button.
- Run ID:** Shows the current run ID as '20131025\_1' and the event number as '9'.
- System Status:** Displays various timing and performance metrics:
  - Compression/Expansion Time: -277.407
  - Event Livetime: 0
  - Run Livetime: 74.206
  - Run Elapsed Time: 380.457
- Log Path:** Shows the log path as 'Z:\storage\2l-13-logs' and the current log path as '987'.
- Snapshot Path:** Shows the snapshot path as 'Z:\storage\2l-13-snapshots'.
- Snapshot Comment:** A text area for entering comments, with a note that comments will be saved in the same directory as snapshot images and PLC data.
- Buttons:** Includes a large green 'RE-INITIALIZE' button and a 'Take Snapshot' button.
- Captured Frames:** Shows two side-by-side camera views of the experiment. The left view is labeled 'cam 0 (cam0) Frame 9' and the right view is labeled 'cam 1 (cam1) Frame 9'. Both views show a dark, cylindrical container with several small, bright spots (bubbles) visible inside. The interface also displays 'Event Frame 2330', 'Frames Skipped 0', 'dT (ms) 10', and 'Hit Pix 2536' for both cameras.

# PICO-2L commissioning data



- Commissioning data with an AmBe neutron source.

- Plot made by mostly running old COUPP-4 reconstruction code, will improve when tuned for this chamber.

- Variable threshold (~4keVnr).

- See a decaying population of alphas (radon), acoustically separate from nuclear recoils.

# Summary

- COUPP and PICASSO have merged to form the PICO collaboration to search for dark matter with superheated liquid detectors.
- COUPP-60 is running with 37kg  $\text{CF}_3\text{I}$  target. No neutron background, but a background population of events under study that are clearly not WIMPs.
- PICO-2L is now running at a 3keV threshold with 2.9kg  $\text{C}_3\text{F}_8$  target. Projected world leading sensitivity for low mass WIMPs and spin-dependent couplings.
- Next generation PICO-250L is being designed, with several potential fluids including  $\text{C}_3\text{F}_8$  and  $\text{CF}_3\text{I}$ , for operation beginning in 2016.